NORTHEASTERN FOREST EXPERIMENT STATION

Division of Watershed Management Research

Semi-annual Report October 1956

GENERAL

Progress was made in several different directions during the past six months - read in that what you will - not including, however, loss of Sid Weitzman to Lake States. Sid, we miss you.

Much of the work at Kingston and Mountain State was directed towards calibration of the watersheds. Hal Wilm gave us a hand in an all-day session at Syracuse attended by Weitzman, Reinhart, Reigner, and Lull.

A second meeting for all Station watershed researchers was held at Hubbard Brook in late August. Watershed programs at the three Centers were described and discussed with particular attention to Trimble's just-finished problem analysis for Hubbard Brook. It was strictly a shop-talk session and everyone was heard. Ed Johnson from CS and Lou Metz SE sat in and came up with some good ideas.

Lull ran out of travel money in April: accordingly, all but two of the manuscripts which had accumulated in his basket have moved to our Editor's basket.

KINGSTON RESEARCH CENTER

Problem analysis

At long last, a problem analysis for watershed management research in the Kingston Research Center area is nearly complete. The analysis will be published as a Station Paper after being reviewed by a number of interested agencies.

In preparation of this report, Reigner travelled to Ithaca, N. Y. to see Earl Stone, Professor of Forest Soils at Cornell and George Free, who is in charge of ARS studies in soils and water at the University. Both men are in close contact with the problem of the poorly drained soils in the Northern Dairy Region--the so-called "Volusia Soils". Our ideas on this problem underwent considerable change after discussions with Stone and Free.

Reigner also spent most of a day in Harrisburg with F. G. Loughry, State Soil Scientist, working up a soils map based on latest information available. A soils map of the Northeast, including Pennsylvania is due for publication by the SCS at some future date.

Weir Maintenance

Although streamflow remained rather high during this cool wet summer, we managed to find a period of flow low enough to drain the weir pool at the Pocono Experimental Forest. In addition to cleaning the pool, we wished to plug a leak which had developed around one wing wall.

After draining the pool and examining the soil material against the back and side of the wing wall, we discovered it to be coarse gravel rather than some more impervious material. It appears this material was backfilled after the removal of the concrete forms during constructions. Naturally, the water moved easily through the gravel and subsequently washed a passage through the undisturbed clay against which the concrete was poured. After the gravel was removed, a large hole was found around the side of the wing wall. This hole, and the void left by the removal of the gravel was filled with concrete. So far, the leak is plugged.

A lesson may be learned from our troubles. A void left by the removal of forms should certainly be filled with impervious material. Concrete is best and not expensive--particularly at the time of construction.

A similar job is needed at the Dilldown weir, but flow has not depleted enough this year to drain the pool.

Watershed Calibration

Reigner has continued to spend most of his time delving deeper and deeper (maybe too deep) into the intricacies of the factors affecting the water cycle. A great mass of information is available and the combinations, weights, and interactions are almost innumerable.

In order to estimate runoff during a period such as a season or year, storage values at the beginning and end of the period are necessary. These values must be estimated, too, from factors which will not be affected by treatment (precipitation and other climatic factors). During the past 6 months, methods were developed to estimate groundwater storage and total storage (groundwater plus soil moisture).

Results are tentative and have not been evaluated. However, as there has been some interest in these analyses, we can give you some highlights.

We have found that total storage (groundwater + soil moisture) at the beginning of a month is highly related to runoff during the month. Temperature enters into the relationship, of course. Mean temperature for the month taken to the 4th power is highly correlated; a better parameter is the mean temperature over 40°. Here, all values under 41° are given a value of zero. The square of the latter variable is still more highly correlated. Unweighted precipitation for the month is well related, with an exponential value indicated.

Soil moisture content at the end of the month is negatively correlated with monthly runoff. The analysis of this factor was most interesting, being complicated by the two upper limits in soil moisture--saturation and field capacity. Obviously, soil moisture cannot increase above saturation no matter how much it rains. And, just as obviously, most observations will be at field capacity or below. We found that the effect of antecedent precipitation decreases to about the 28th day prior to the point of measurement, at which time its effect is zero. In order to weight the precipitation value properly, a curvilinear weighting system was applied, with the most recent rainfall being given an exponentially greater weight than earlier rainfall.

The temperature variable is also involved. Testing the exponential values of mean temperature for the previous month, we ran up to about the 9th power, at which time we discovered the low temperature values had no effect on soil moisture. Only temperatures over 60° had any effect on reducing soil moisture. A linear expression of temperature was devised with 61° given a value of 1, 62° given a value of 2, and so on, with all values under 61° called zero. It was much better related than the exponential forms of temperature. Next, average maximum temperatures were tested against mean temperatures; the differences were not great, but maximum temperature over 67° gave the greatest reduction in mean square.

The upper soil moisture limits also limit the amount of rainfall affecting soil moisture. For our conditions, we found this limit to be about 2 inches. Any rainfall over 2.0 inches per 28 days (on a weighted basis) would satisfy retention storage and percolate into groundwater--with an important exception--when water use is high. An interaction of the precipitation and temperature variables satisfies this condition.

The equation may be stated: Soil moisture content at the end of the month = a + b_1 Weighted Precip. up to 2.1 inches - b_2 Average Maximum Temperature over 67° + b_3 Weighted Precip. x Ave. Max. Temp. over 67°. This equation does not estimate soil moisture above field capacity --an infrequent condition--and has an accuracy to 0.28 inches of soil moisture storage in 24 inches of soil. (For this depth, field capacity is 6.95 inches and lowest moisture content reached 3.80 inches). We feel sure that these estimates could be improved, but only by means of other and more complicated variables and interactions.

Art Eschner has been carrying along an analysis of peak flow determinations in the little amount of spare time he has. Using increase in flow as the dependent variable, the best correlations so far were obtained from the square of storm precipitation and an interaction between P^2 and the flow at the beginning of the peak.

Late in April, Reigner joined Howard Lull, Sid Weitzman, and Ken Reinhart in a trip to Syracuse. There we went over all of this calibration business with Hal Wilm. As the Fernow calibration methods are based on a control watershed instead of a single watershed, the discussions were quite varied and most informative. Dr. Wilm gave us a number of worthwhile suggestions including the use of a covariance analysis to check the independence of the values from year to year.

Miscellaneous

Some of the earliest watershed experiments in the Northeast were conducted in the early 40's by the Soil Conservation Service on the Arnot Forest, near Ithaca, N. Y. Reigner visited these watersheds in company with Stone and Free during his trip to Cornell. The primary object of the studies was to determine differences in erosion between forested watersheds and idle land watersheds. As the idle lands had a complete cover of weeds, grasses, and brush, there was no erosion from any of the watersheds.

Although there may have been some confounding of results due to soil differences, an interesting comparison of runoff pattern was developed from these watersheds. On an annual basis, there was no difference in yield between the two types of land use. But there were considerable differences in seasonal yields; during the period June-September, the idle land yielded over twice as much runoff as the forested watersheds.

Also while at Cornell, Reigner met Dr. E. R. Lemon, Soil Physicist for ARS, who had recently come to Cornell from Texas. He described some of the evapo-transpiration studies going on at Texas, A & M. Their work using net radiation data and the heat budget approach is most interesting. We plan to visit Dr. Lemon again to discuss possible applications to our work.

Eschner attended the Northeastern Forest Soils Conference at Burlington, Vermont, early in August.

Later in August, Reigner and Eschner joined the other watershed management personnel in a three-day meeting at Hubbard Brook, New Hampshire. Mostly, we discussed and looked over the Hubbard Brook program which is getting under way nicely. But we also described and discussed the watershed management programs of the Kingston and Mountain State Centers. The weather and accommodations were fine, the discussions were learned, but the hills were just as steep as in West Virginia.

The annual INCODEL meeting came along late in September with Reigner and Eschner attending. One of the most interesting papers was the report of the Delaware River Master who is in charge of releases from the recently completed New York City reservoirs in the upper Delaware River drainage. On one day this past August, 76 percent of the flow of

the Delaware River at Port Jervis, N. Y. was derived from the two reservoirs now completed. After the Cannonsville Reservoir is finished, the contribution to supplementing low flows will be considerably greater.

The last week in May and the first in June, Eschner spent in West Virginia on a training detail. When he reached there the watersheds of the Fernow were really shedding water--causing quite a flurry of activity. The pitch of the activity did not appear to lessen during his stay.

MOUNTAIN STATE RESEARCH CENTER

Soil-Moisture Study

A soil-moisture study got underway about on schedule--thanks to added assistance from Don Lester of Upper Darby and Art Eschner of Kingston. The purpose of the study is to determine changes in soil moisture created by different cutting practices.

It was pleasant to find that the King tube works quite well despite the stoniness of our soils. This eliminates necessity for digging pits to collect samples.

A wet spring and frequent summer rainfall have limited the range of soil moisture measured.

Perhaps the most serious problem is how to determine the stone content of our samples. In sieving out stones, how much force should be used to break up the material? In other words, where is the dividing line between soft stone and hard soil? Consistency in results may be hard to obtain. We are open to suggestions.

Watershed Calibration

An analysis on our original 5 wooded watersheds to determine adequacy of the calibration period has taken considerable time. In April, Lull, Weitzman, Bickford and Reinhart discussed the problem with Hal Wilm at Syracuse. This discussion led to a clearer understanding of our objectives and ways of attaining them.

The analysis indicates that the 5-year results are much better to work with than the 4-year results previously analyzed. The data look good; annual and monthly flows and peak flows of the 5 watersheds are closely correlated and it is possible to predict flow of one from that of another with a small error of estimate. A first try has been made on analysis of low flows using number of days in each year when flow was below 0.050 c.s.m. This amount of flow was chosen because each watershed in each year had at least a few days when flow fell below this value. Results of this analysis are encouraging but efforts will be made to find a better way of approaching the problem of low flows.

Higher than average rainfall for the period--including several good-sized storms--resulted in opportunities for collecting water quality samples.

New weirs

Streamflow records will begin November 1 at weirs 6 and 7 whose cutoff walls were poured last fall.

Cutoff walls for weirs 7 and 8 - for the pasture rehabilitation study - were poured in June.

Tilted gages

Our precipitation gages on the Fernow were installed vertically and we have, of course, been concerned over whether or not we were getting a proper catch. Therefore at 4 sites, gages tilted with the slope were installed and their catches compared with catches from the vertical gages. Over a 9-month period, catches of the 4 tilted gages were 99.8, 97.5, 99.7, and 99.5 percent of the catches from their vertical counterparts. Catches for individual months and individual storms were very close for the two types of gages. We feel that we can go ahead and rely on catches from our vertical gages on our gaged watersheds. However, at one site outside of our gaged watersheds, the tilted gage caught 5 percent more than the vertical. We will want to study that situation further and determine what factors were responsible.

Personnel

Sid Weitzman left the fair hills of West Virginia for the blizzards and icy winds of Minnesota. He'll head up the watershed management research at the Lake States Experiment Station. His first major project - to find some cheap chemical to add to all the water up there to give it the taste and wallop of Bullett County corn.

Real big news was Carl Barr's Superior Service Award which he received in Washington, D. C. on June 5. Carl really deserved this award for helping to make the research program on the Fernow click and for doing such a good job in getting the results of our experiments across to visitors and the general public. Soon after he received the award, he was back on the job working as hard as ever. We wonder if the Department awards Oak Leaf Clusters.

Emmanuel Van Nierop, who received his Master's degree from Syracuse in June, spent the summer working in the soil-moisture study. His visa expired and he returned to Canada September 7.

John Phillips, Soils Scientist, arrived on the job July 2 straight from the campus of the University of Wisconsin.

Meetings

4/19-20 - Weitzman and Reinhart visited New York State College of Forestry to discuss watershed calibration with Lull and Wilm.

8/26-30/56 - Reinhart, Phillips and Fridley attended a watershed management conference at the Hubbard Brook Experimental Forest in New Hampshire.

9/20/56 - Reinhart and Phillips attended the W. Va. Chapter meeting of the S.A.F. at Camp Pocahontas, W. Va.

9/21/56 - Reinhart and Phillips attended the W. Va. Chapter meeting of the Soil Conservation Society of America at Jackson Mills, W. Va.

WHITE PINE-HARDWOOD RESEARCH CENTER

General

It was a long time coming, but spring finally did arrive in these parts. We still had snow on the higher north slopes of the watershed in the latter half of May. As it was, the trees were beginning to leaf out on some parts while we still had snow on others. Fortunately for our contour map-making project, the Navy was able to fly the area and get the necessary pictures in the few days time between the snow and the leaves.

A field survey crew from the Alexandria, Virginia Photogrammetric Field Unit (who is making our map) was here for a couple weeks doing ground control for the mapping job. Sartz pinch-hitted for one of the men who had to return home unexpectedly. An interesting sidelight of this job was that, while occupying the peak of Mount Osceola, the party recovered one of the original U. S. Coast and Geodetic Survey triangulation stations established in 1875, and since lost.

In its first cleaning--after 8 months of operation--the stilling basin of the weir yielded plenty of leaves, twigs and sticks, and one dead frog, but a negligible amount of sediment. The debris basin at the head of the stilling basin, however, held about nine-tenths of a cubic yard of sand and gravel. Cleaned again after a very heavy rain in mid-summer, the basin yielded nearly 2/3 as much coarse material again. It appears that most of the debris collected so far resulted from stream channel disturbance just above the weir that occurred during construction. At present the channel appears to have stabilized again. We're sold on debris-collecting structures above stilling basins in this area of coarse-textured soils.

Skidroad revegetation

A recent expansion has been made of the logging road seeding project at Bartlett, a joint timber management-watershed management project. Now under study for possibilities of seeding down logging roads and trails for erosion control and game food are the following--with and without lime and fertilizer:

1. Barn chaff
2. Orchard grass
3. Rye
4. Oats, timothy, and red top (equal proportions by weight)
5. Red fescue (44%), Kentucky blue grass (20%), red top (20%), domestic rye grass (12%), White Dutch clover (4%)
6. Creeping red fescue (70%), birds foot trefoil (30%)
7. Tall fescue (70%), birds foot trefoil (30%)

Our skidroad revegetation experiment has now encompassed two growing seasons. Preliminary results from this work indicate that several grasses appear to offer excellent protection against erosion on logging roads. While the results are by no means conclusive at this date, we feel that the following grasses can be seeded to good advantage:

Red top
Creeping red fescue
Tall fescue
Orchard grass
Barn chaff

In the White Mountain area, it is necessary to use at least 400 pounds of fertilizer per mile of skidroad to obtain good growth. A 10-10-10 fertilizer is recommended. Tentatively, we also recommend that about one ton of lime--preferably dolomitic lime--be used per mile of road.

Woodland field day

This field day, sponsored by the Extension Service, was held at the Belknap Recreation Area near Laconia in April. This was a public demonstration of good forestry practices. The watershed research unit helped with a demonstration of logging and skidroad layout and maintenance. The affair was well attended and apparently was a great success.

Trimble is cooperating with Extension Service foresters in preparing a leaflet on logging and skidroad practices for New Hampshire.

Show-me Trips

The watershed staff conducted its first full-scale show-me trip of the Hubbard Brook Experimental Forest in June. Three groups (40 altogether) of the Conservation Camp, an annual one-week workshop sponsored by the Society for the Protection of New Hampshire Forests, braved our temporary road and steep climb to look over the weir and weather station installations. In addition, they looked at soil pits and discussed moisture relationships of forest soils. It was an interested and enthusiastic group and we enjoyed having them. (The fact that quite a few were female, young and pretty had nothing whatsoever to do with this). (Humph!)

Professor Harold Hocker from the University of New Hampshire brought a group of forestry students to the Hubbard Brook Experimental Forest for a show-me trip to acquaint them with forest watershed management problems in this area. Nine company foresters for the Draper Corporation visited the Hubbard Brook Experimental Forest in September.

Meetings

Pierce attended the annual meeting of the Northeastern Forest Soils Group in Burlington, Vermont in August.

Trimble attended the summer meeting of the New England Section of the Society of American Foresters in Orono, Maine during the first part of September.

Sartz and Pierce attended a 3-day photographic school given by Charlie Lockard at Bartlett in September.

A highlight of the summer season was the watershed management research conference held at Hubbard Brook in August. All of the personnel engaged in watershed management research in the Northeast attended this meeting. In addition, Lou Metz of the Southeastern Station, and Ed Johnson of the Central States Station were guests. This 3-day meeting included both discussion and field trips on the Hubbard Brook Experimental Forest and nearby areas. The tentative draft of the problem analysis for the White Mountain area was discussed and watershed calibration procedures for both the Pocono and Mountain State areas were also discussed by the group. We felt that the meeting accomplished a number of objectives by getting together men with similar interests and mutual problems. Both Lou Metz and Ed Johnson made a number of comments and suggestions which were very useful to the Northeastern group. Howard Lull conducted the meeting and summarized the highlights in a brief memo.

During the summer season, 3 weir sites were prepared and a 3/4 mile jeep road built to make them accessible. Construction on one of the weirs is about finished, and we expect to have this watershed operating by the beginning of the dormant season.

Howard Lull spent a week with us in April working on the frost and humus papers and reviewing an early draft of our watershed research problem analysis.

We enjoyed a three-day visit from Sid Weitzman in June. Sid spent some time at Hubbard Brook and made a number of helpful suggestions. We're sorry he sprained his knee and suffered so from insect attacks. It seems that the gentle terrain and benign wildlife in West Virginia are poor preparation for New Hampshire's rugged outdoor environment. We understand now why the Fernow boys were so amazed at Russ Hutnik's stamina when he transferred down there from Laconia.

Ray Lavigne, Frank Cunningham's right-hand man at the Hopkins Forest for the past few years, transferred to us at the end of June. He and his family now live within a couple of miles of the watershed.

Our student assistant this summer was Bill Kerr, a 1956 geology graduate of Massachusetts State University.

Trimble reported seeing a moose track up in the watershed. To add credence to this tale, Sid Weitzman was with him at the time.

COASTAL OAK-PINE RESEARCH CENTER

Si Little, Horace Somes, and Howard Lull, with cooperation of the Geological Survey, Soil Conservation Service and soil surveyors, and Seabrook Farms, started a study in September to determine the effect of water spreading in tree growth, understory composition, and soil characteristics. Two pairs of plots were selected, one affected and one unaffected by water spreading. On the treated plots, water had been applied at the rate of about 600 inches a year for the past 6 years. To date, vegetation has been tallied, soils described and classified, and soil samples taken. The water is applied to these areas through rotating nozzles which thoroughly wet down all vegetation. According to bark characteristics, all oaks in the treated area belong to a new species, Quercus slimiyi.

PUBLICATIONS

Report No. 3. Forest and water research project. Delaware-Lehigh Experimental Forest. Irvin C. Reigner, W. E. McQuilkin, E. F. McNamara, and Howard W. Lull. 44 pp., illus. Harrisburg.

Snow storage and melt in a northern hardwood forest. Richard S. Sartz and George R. Trimble, Jr. Jour. Forestry 54: 499-502.

Manuscripts submitted

Water yields from small forested watersheds. Sidney Weitzman and K. G. Reinhart.

Influence of land use and forest condition on soil freezing and snow depth. Robert S. Pierce, Howard W. Lull, and Herbert C. Storey.

The role of forest humus in watershed management in New England. George W. Trimble, Jr. and Howard W. Lull.

Factors influencing streamflow from two watersheds in northeastern Pennsylvania. Howard W. Lull and Herbert C. Storey.

A program of watershed management research on forest lands in the upper Delaware and Susquehanna river basins. Howard W. Lull and Irvin C. Reigner.

Physical properties of 123 soils in the Northeast. A. R. Eschner, B. Jones, and R. C. Moyle.